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DEVELOPMENT OF HEALTH AND SAFETY STANDARDS OF WORK MICROCLIMATE IN INDONESIA

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ABSTRACT

As a tropical country, Indonesia should determine work microclimate standards to safeguard the human factor in the working environment. Average air temperature in this country ranges from 24.0 to 27.1 °C, with relative humidity never less than 65%. Radiation heat is usually 28–29 °C indoors and 30 °C outdoors. Evaporation is an important mechanism ensuring a balanced body temperature. Unless the fluid balance is maintained, body weight will be reduced. A wet bulb temperature of 30 °C is generally considered as the point at which some untoward effects become observable. The Belding Hatch Index indicated very high percentages, although no complaints on the part of the workers were recorded. Further study showed that a wet bulb globus thermometer (WBGT) assessment might have been more suitable. For WBGT less than 27.7 °C there were no complaints or sensation of heat stress, the latter becoming noticeable at 28.9–29.6 °C. When the WBGT exceeds 30.2 °C, the heat stress becomes unbearable. For cold workplaces, the threshold is 21 °C wet bulb. The comfort zone is about 24–26 °C dry bulb.

Work microclimate is a combined effect of air temperature, humidity, air velocity, radiation heat and level of work activity. It influences, favourably or unfavourably, the levels of comfort and work productivity, depending on the degree of heat stress.

Under the Basic Labour Law of 1969, a worker is entitled to proper protection of health and safety according to norms to be laid down by the Government. The 1970 Safety Act also includes regulations regarding work air temperature and humidity (microclimate).

The country's industrial sector, which accounts for 12.5% of the national income and employs about 10 million people, has an annual growth rate of 13%. Many of the work processes proceed in relatively hot working conditions, and ill effects of such hot environments on the worker's health have repeatedly been observed. It is estimated that in Indonesia about one million workers perform their jobs in hot environments. In addition to hot environments, new technologies introduced in various processes (preservation of fish, shrimps, etc.) have created cold working environments.

INDONESIA AS A TROPICAL COUNTRY

Situated on the equator which divides it into two parts, Indonesia is a tropical country. There are only dry and hot and cold and rainy monsoon seasons. The average temperature is generally stable throughout the year with variations of only one or two degrees. It varies, however, from place to place depending on the altitude. The higher the altitude, the cooler the climate. Jakarta represents the country's hot areas (26.6–27.1 °C) and West Java the cooler ones (24.1–24.4 °C). However, there are sometimes hot spells with temperature increasing by five or seven degrees centigrade, especially during long hot seasons. There is a high humidity in both areas, usually on an average of 80% and never less than 65%.

Thus, Indonesia is marked by a warm and humid climate and its inhabitants are a tropical people physiologically adjusted to warm and humid environments.

Radiation heat from the sun is high. In many measurements, globe temperatures showed more than 30 °C outdoors, and 28–29 °C indoors, depending on the amount of insolation.

Occupational heat stress and standards of protection

Since 1967 many studies have been devoted to the assessment of heat stress for the purpose of protecting the workers' health. The National Institute of Occupational Health and Industrial Hygiene has conducted routine services in industrial enterprises by measuring the existing heat stresses and giving advice on control techniques. So far, this institution has served 3 140 industrial establishments with a total labour force of 181 280.

High temperature may cause various maladies such as heat stroke, heat cramps, heat exhaustion, dehydration, tropical fatigue and miliaria. In our experience, these illnesses have been very seldom observed. It is worth noting that not a single case of the classical heat cramps has been reported, though several cases of heat stress with chronic diarrhoeal symptoms have been found. We also believe that certain temperatures at workplaces are the cause of a prevalence of certain common diseases such as common cold, influenza, etc. producing general symptoms and leading to complaints by the workers. These microclimatic conditions usually result in a chronic loss of weight caused by loss of water due to evaporation. In a study at a textile mill I measured two groups of workers each exposed to a different degree of heat stress. The difference in body weight was 5.6 kg, while all other conditions were comparable. The cause was found to be due to loss of fluid from the body through evaporation of sweat in response to the hot and humid environment. The loss of fluid could also be observed from the average blood pressures before and after work. Average blood pressure, measured early in the morning, was 114.4 mm Hg systolic and 76.4 diastolic for administrative employees, and 103.5 mm Hg systolic and 68.5 diastolic in persons exposed to heat stress. Further experimentations revealed that correction of the water balance improved the condition.

The Workshop on Occupational Health and Hygiene Standards, organized in 1974, in which a number of occupational health specialists and industrial

hygienists participated, recommended certain principles on which health and safety standards of work microclimate should be based. It was stated that the combination of hot temperature and a high humidity degree are the primary factor of heat stress. Because of this wet bulb temperatures should be regarded as an indicator of the effects of microclimate, while according to extensive experience, 30 °C wet bulb temperature could be considered as the point where some untoward effects become observable.

The 30 °C level has since been widely accepted as a safe limit. Above that level temperature should be reduced and/or proper protective devices and/or other means of protection introduced. The Minister of Labour has also issued a circular along these lines to be observed by industrial enterprises.

Applicability and adequacy of the heat stress standard

Experience has confirmed the applicability of the standard. For the standard procedure, at least three kinds of psychrometers, i.e. a whirling psychrometer, an Arsman psychrometer or an August psychrometer, are used. With one of these apparatus, both wet bulb and dry bulb temperatures are measured, the relative humidity being determined subsequently by means of a psychrometric chart.

In compliance with the ministerial circular, the wet bulb temperature of the microclimate should not exceed 30 °C provided that the relative humidity lies between 65 and 95%. Whenever this limit is exceeded, corrective or preventive measures should be taken. These might include the following:

1. The application of control technology to reduce the heat stress so that the wet bulb temperature becomes lower than the limit.
2. The use of devices which will protect the workers from exposure to existing heat stresses.
3. The reduction of strain by maintaining the body water balance through the intake of enough fluid, by adjusting work so as to reduce the heat component arising from metabolism, etc.

The procedures have been and will be more extensively explained to those concerned. Technicians are given the respective training and they adopt the methods with ease. The wet bulb temperatures are shown on the walls of the work environment as recommended by the circular.

Heat stresses can be assessed by measuring the effective temperatures, corrected effective temperatures, heat stress indexes, etc. Each method has its advantages as well as disadvantages. I would like to present here several examples of our findings on heat stress measurements expressed in dry bulb temperature, wet bulb temperature, the Belding Hatch Heat Stress Index (%), and wet bulb-globe temperature index.

As seen from Table 1 the B. H. heat stress indexes were often rather high, while the workers had no complaints. In some cases, the indexes reached several hundred points. The WBGT values were always between the dry bulb and wet bulb temperatures. This fact pointed to the possibility of using WBGT as a guide for better microclimate health and safety protection. The differences between dry

TABLE 1
Several factories and their levels of heat stress.

Factory	Location	Heat stress			
		Dry bulb (°C)	Wet bulb (°C)	B.H. heat stress index (%)	WBGT (°C)
Shoe manufacture	Assembly	32.8	25.9	116.3	28.2
	Diesel room	36	26.5	518	29.3
Match production	Sieving and drying	34.5	26	911.9	29.2
	Dipping	33.5	26	917	29.5
Car assembling	Painting	32.5	26	65.9	28.3
Plastics	Handling plastics	32.7	26.5	52.4	28.4
Dock work	Floating	31	26	157.4	30.2
Iron and steel	Rolling	32.2	26.2	118.6	29.9
Industrial equipment	Packing	28.8	20.8	33.3	23.6

and wet bulb temperatures were found to be sufficiently great and sometimes more than 5 °C due to a lower relative humidity (less than 65%).

The possibility of using the WBGT index as guide of practice was also explored. A study was carried out in six factories where 48 persons (27% sample) were examined and interviewed regarding their complaints and sensations of heat stress. About 60% of them stated they felt the heat, and all of them were working in areas with WBGT varying from 28.8 to 29.6 °C. Those who did their jobs in a workroom temperature of WBGT exceeding 30.2 °C stated that the conditions were unbearable. With WBGT less than 27.7 °C, they felt no heat stress effects.

Further actions concerned with these problems included an investigation of workplaces in 9 enterprises with an average WBGT of 30.45 (S.D. 1.38). The other parameters showed an average 508.17 B. H. heat stress index, 4.62 average P4SR, and 28.4 °C average wet bulb temperature. For the evaluation, 27 (25.5%) persons were taken at random from a total population of 106. The following findings were reported: 26 (96.3%) persons felt the heat stress; 13 (48.2%) felt very tired before finishing work; 25 (92.6%) persons felt they perspired too much; 9 (33.3%) persons perspired at a rate of more than 5 liters within 4 hours. Most of the complaints referred to intestinal pain, headache, nausea, too much sweating, exhaustion, thirst, anorexia, intestinal cramps, fever and feelings of discomfort.

Statistical analysis of the WBGT indexes and wet bulb temperatures showed that the standard deviation (1.38) for the average WBGT was lower than for the wet bulb temperature (1.97 °C).

The factories had taken the following preventive measures against the effects of heat stress: five of them had already provided working clothes made of cotton to facilitate evaporation; seven had made drinking water available to the workers during working hours; resting places, canteens and meals had been organized by six of them. However, none of the factories makes use of salt tablets for preventive purposes.

Cold workplaces and comfort zone

On the basis of the experience gained from the activities of the National Institute and after confirmation by occupational health specialists and industrial hygienists in this country, 21 °C wet bulb temperature has been accepted as the standard for cold work environment. In many occupations, temperatures below this standard affected the health of the workers and led to many complaints. An illustration of this is a modern centrally air-conditioned building to which the company had just moved its employees. The Institute was asked for advice because many employees suffered from common cold, from upper respiratory infections, etc., and there was also a relatively high rate of absenteeism. Institute recommended among other things control of temperature at about 25 °C. The conditions improved and there were no more complaints. The microclimate is also a factor of better welfare and work productivity. Therefore, the comfort zone of the area of thermoneutral condition should be known.

CONCLUSIONS

The present limit values for temperatures of the work microclimate are between 21 and 30 °C wet bulb temperature. These TLVs apply to tropical populations living and working in a warm and humid environment. Experience has shown that the difference between the outside air and the comfort zone should not exceed 5 °C. The comfort zone lies between 24–26 °C dry bulb temperature. In future, the limit of 30 °C wet bulb is to be replaced by 30 °C WBGT index.