the leucocyte count of the blood and other factors dealing with man's mechanism of defense against infection.

Another of the deleterious effects of high temperatures is that the blood is diverted from the internal organs to the surface capillaries, in order to serve in the process of cooling. This affects the stomach, heart, lungs and other vital organs, and it is suggested that the feeling of lassitude and discomfort experienced is due in part to the anaemic condition of the brain. The stomach loses some of its power to act upon the food, owing to a diminished secretion of gastric juice, and there is a corresponding loss in the antiseptic and antifermentive action which favors the growth of bacteria in the intestinal tract[23]. These are considered to be the potent factors in the increased susceptibility to gastro-intestinal disorders in hot summer weather.

In warm atmospheres, particularly during physical work, a considerable amount of chloride is lost from the system through sweating. The loss of this substance may lead to attacks of cramps, unless the salts are replaced in the drinking water. In order to relieve both cramps and fatigue, it is recommended that 6 g of sodium chloride and 4 g of potassium chloride be added to a gallon of water[24].

The deleterious physiologic effects of high temperatures exert a powerful influence upon physical activity, accidents, sickness and mortality. Both laboratory and field data show that physical work in warm atmospheres is a great effort, and that production falls progressively as the temperature rises. The incidence of industrial accidents reaches a minimum at about 68 F, increasing above and below that temperature. Sickness and mortality rates increase progressively as the temperature rises.

The need of air conditioning for workers in hot industries is growing rapidly and this should become an important field for the air conditioning engineer. The hot conditions may be remedied by any of the recognized comfort cooling applications. The choice of the type of system and cycle to be used in a given instance must be determined by the air conditioning engineer after a study of surrounding conditions.

In some hot industries where a small number of workers are engaged in spaces of large volumetric capacity the worker himself, rather than the entire environment, can be cooled by either placing him in a small cooled and ventilated booth, by blowing cooled air over him, or by circulating cooled air through a loose-fitting suit.[25]

RELATION OF AIR CONDITIONING NEEDS TO METABOLISM

The major objective of heating and ventilation is to balance heat losses from the human body. The basic factor is metabolism. The desirable environment, from the standpoint of heat loss, depends directly on the heat produced in the body and this heat may be over ten times as great when a man is exercising violently as when he is reclining and at rest. Therefore, there is no absolute optimum of air temperature or other environmental conditions, which will meet all cases. With moderate, (45 per cent) relative humidity and minimum air movement, an air temperature of 80 F has been found ideal for the lightly clothed subject at rest in a semi-reclining position, while normally clothed, healthy persons

[23]Influence of Effective Temperature upon Bactericidal Action of Gastro-Intestinal Tract, by Arnold and Brody (*Proceedings Society Exp. Biol. Med.*, Vol. 24, 1927, p. 832).

[24]Some Effects of High Air Temperatures Upon the Miner, by K. N. Moss (*Transactions Institute of Mining Engineers*, Vol. 66, 1924, p. 284).

[25]A.S.H.V.E. Research Report No. 1188—Local Cooling of Workers in Hot Industry, by F. C. Houghten, M. B. Ferderber and Carl Gutberlet (A.S.H.V.E. Transactions, Vol. 47, 1941, p. 403).

have been found comfortable at 72 and 77 F with 45 per cent relative humidity (or 67 and 71 deg ET, respectively) for winter and summer conditions. In factories where light work is performed in summer time, the ideal has been found to be about 76 F. For children (who have a high

Table 3. Relation Between Metabolic Rate and Activity[a]

Activity	Hourly Metabolic Rate for Avg Person or Total Heat Dissipated, Btu per Hour	Hourly Sensible Heat Dissipated, at 79 F, Btu per Hour	Hourly Latent Heat Dissipated, at 79 F, Btu per Hour	Moisture Dissipated per Hour per Person	
				Grains	Pounds
Basal	291	145	145	978	0.140
Seated at Rest	384	225	159	1072	0.153
Reading Aloud (Seated)	420	225	195	1315	0.188
Standing at Rest	431	225	206	1389	0.198
Hand Sewing (Seated)	441	225	216	1457	0.208
Knitting 23 stitches per minute on Sweater	462	225	237	1598	0.228
Dressing and Undressing	468	225	243	1639	0.234
Tailor	482	225	257	1733	0.248
Singing	486	225	261	1760	0.251
Office Worker Moderately Active	490	225	265	1787	0.255
Light Work Standing	549	225	324	2185	0.312
Typewriting Rapidly	558	225	333	2246	0.321
Ironing with 5 lb iron	570	225	345	2326	0.332
Dishwashing—Plates, Bowls, Cups and Saucers	600	225	375	2529	0.361
Clerk Moderately Active Standing at Counter	600	225	375	2529	0.361
Book Binder	626	225	401	2704	0.386
Shoemaker	661	225	436	2940	0.420
Sweeping Bare Floor 38 Strokes per Minute	672	229	443	2987	0.427
Pool Player	680	230	450	3055	0.434
Walking 2 mph, Light Dancing	761	250	511	3446	0.492
Light Metal Worker (at Bench)	862	277	585	3945	0.564
Painter of Furniture (at Bench)	876	280	596	4019	0.574
Carpenter	954	307	647	4363	0.623
Restaurant Serving	1000	325	675	4552	0.650
Pulling Weight	1041	335	708	4774	0.682
Walking 3 mph	1050	339	711	4795	0.685
Walking 4 mph, Active Dancing, Roller Skating	1390	452	938	6325	0.904
Walking Down Stairs	1444	467	977	6588	0.941
Stone Mason	1490	485	1005	6777	0.968
Bowling	1500	490	1010	6811	0.973
Man Sawing Wood	1800	590	1210	8160	1.166
Swimming	1986	......	......	......	......
Running 5.3 mph	2268	......	......	......	......
Walking 5 mph	2330	......	......	......	......
Walking Very Fast 5.3 mph	2580	......	......	......	......
Walking Upstairs	4365	......	......	......	......
Maximum Exertion Different People	3000-4800	......	......	......	......

[a]These metabolic rates were compiled by the A.S.H.V.E. Research Laboratory from actual tests, from other authoritative sources, and from estimates based upon various considerations. Division of the total heat dissipation into latent and sensible rates is based on actual test data and on various considerations for metabolic rates up to 1250 Btu per hour, and extrapolated for higher rates. Values for total heat dissipation for a person at rest apply for a dry-bulb temperature range from approximately 60 to 90 F; for other than rest conditions the values apply for a similar but lower temperature range. Below these temperature ranges metabolic rates and total rates of heat dissipation increase, while above these ranges metabolic rates increase slightly and total heat dissipation rates decrease rapidly. Division of total dissipation rates into sensible and latent heat holds only for a dry-bulb temperature of 79 F. For lower temperatures, sensible heat dissipation increases and latent heat decreases, while for higher temperatures the reverse is true.

metabolism) at school, in winter clothing, 70 F has been considered correct; while in a gymnasium, 55 F has been recommended.

The wide variations in metabolic activities with which the engineer must be prepared to cope and the influence of such variations in metabolism on the heat load contributed by the human body to the environment