

INTRODUCTION

Working in agro-food industry behaves workers to be exposed to various risk factors e.g. chemical agents, noise, posture, manual handling of loads etc. Among these the most peculiar and the least investigated is constituted by microclimatic conditions during the different work steps. Cold thermal stresses are estimated by microclimatic index: in particular, in agro-food industry range, a cold strain condition. The variation of environmental parameters during the working day makes the evaluation very difficult.

MATERIALS AND METHODS

The heat loss by convection is a main part of the heat loss of the human body, particularly in moderate climates. In hotter environments, the heat loss depends more on evaporation, itself function of the characteristics of clothing. An important aspect of the transfers of heat to convection and evaporation is the effect of wind velocity and movements on the transfer coefficients on the surface layer of the clothes. A factor played by clothing in the heat transfer is that it increases the heat transfer surface between the body and the environment. This increase is larger as the clothing is thicker and more insulating. The relation between the average temperature of the skin (t_{sk}), the main climatic parameters, the metabolic rate and the rectal temperature was represented by an additive model.

There are two different types of temperatures that influence the heat exchanges from the operator to the outside; one is the temperature of the skin and the other one is the temperature of the external surface of the clothing. It is also possible to identify a layer of air and a layer constituted by the fabric of the same clothing between the surface of the skin and the external surface of the clothing (figure 1). The two layers oppose a resistance to the transfer of the sensitive heat coming from the body (H) measured in [m^2 KW]. In situations of rest it can be hypothesized that the thermal sensitive exchange through clothing, H , equalizes the general thermal exchange for convection, C , and for radiation, R , that leaves the surface of the covered body.

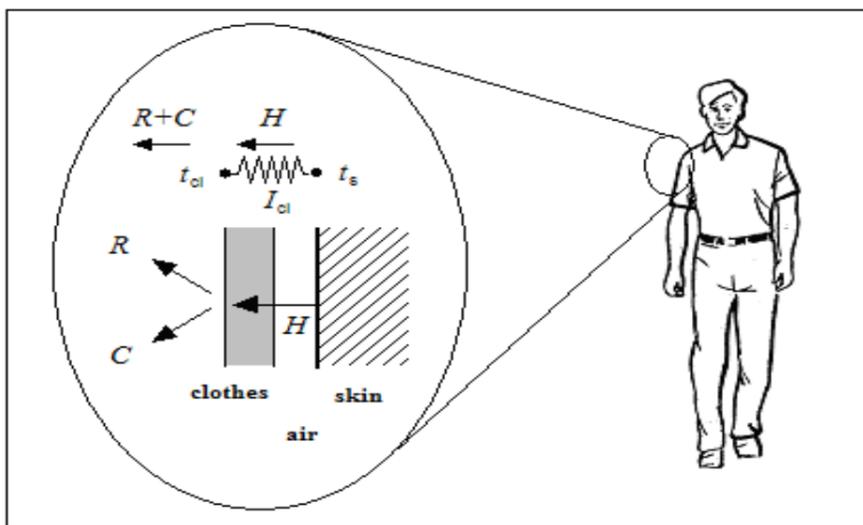


Figure 1: Representation of the thermal sensitive exchange.

The assessment was based on the standard EN ISO 11079 "Determination and interpretation of cold stress when using required clothing insulation ($IREQ$) and local cooling effects".

Instruments

To survey environment parameters, the unit LSI BABUC M (LSI LASTEM s.r.l., Settala, Italy) with six inputs was used connected to 3 probes: a psychrometric probe BSU102 with forced ventilation and a distilled water tank, used for measuring the air temperature (t_a) and the temperature of the damp bulb (t_w); an anemometric probe with hot wire BSV101, to measure the speed of the air (V_a); a global thermometric probe BST131 in black opaque copper (reflection < 2% ASTM 97-55) for measuring the average radiating temperature (t_{ry}) (probes in compliance with the standard ISO 7726).

MONITORED FARM

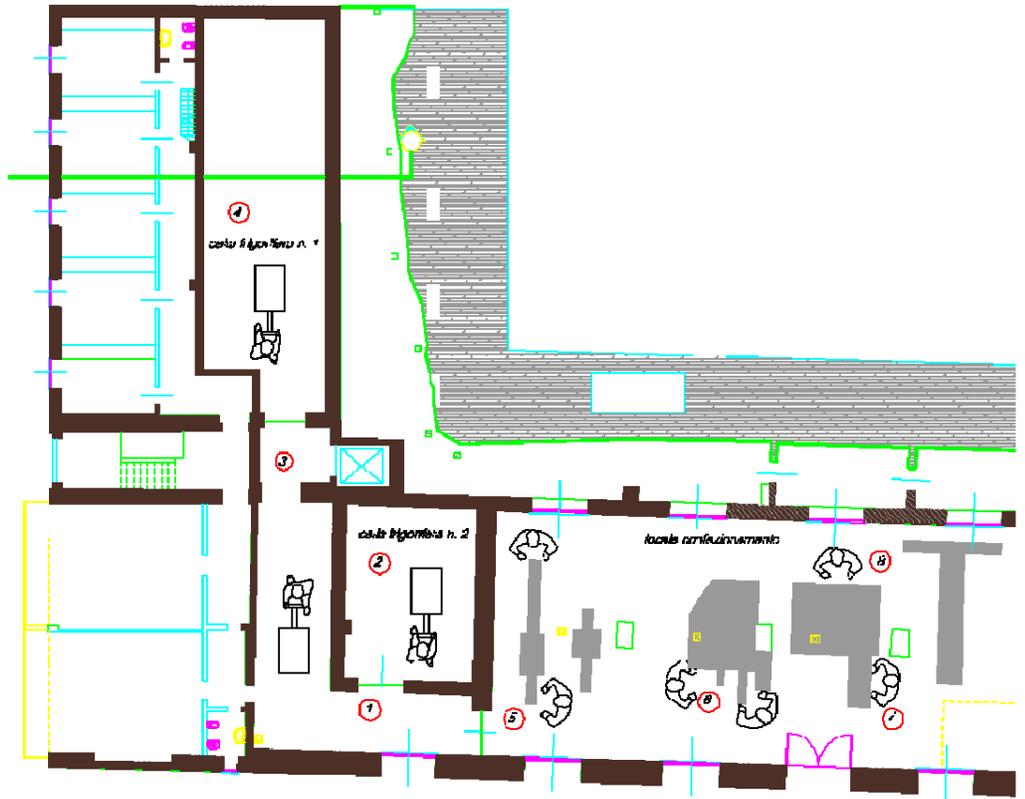


Figure 2: Layout with the workplaces taken into account.

A dairy located north of Rome was monitored, assessing with the use of "IREQ model" the risk of excessive thermal load for workers. In particular eight workplaces were evaluated (figure 2).

RESULTS

Test nr.	Environmental parameters				Met	I_{clr}	IREQ neutral	IREQ min	DLE _{min} (hours)	PMV	PPD %
	t_a °C	t_r °C	V_a m/s	U_r %							
1	9,35	10	0	56,9	95	1,23	1,7	1,3	1,9	-3	99
2	4,5	5	0	30	95	1,23	2,1	1,7	0,1	-3	99
3	8,5	9,8	0	57	95	1,23	2	1,6	1,9	-3	99
4	4,5	5	0	30	95	1,23	2,1	1,7	0,1	-3	99
5	9,97	10,7	0	59,1	95	1,23	1,7	1,3	1,8	-2,9	98,6
6	9,69	10	0	56,9	95	1,23	1,8	1,5	1,9	-3	99
7	11,17	11,24	0	55,8	95	1,23	1,8	1,5	1,9	-2,6	95,3
8	10,71	10,94	0	58,1	95	1,23	1,7	1,4	1,9	-2,7	96,7

CONCLUSIONS

The results show, in each station analyzed:

$$I_{clr} < IREQ_{min}$$

In conclusion, the present study shows that health risks are actually present, but they can be controlled through proper selection of clothing. In these cases it is not possible, in fact, to modify the environmental parameters, given the nature of the raw material used in the production cycle.