



**ENVIRONMENTAL-FRIENDLY
COLD WATER THAWING PRACTICE**



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Aims and Objectives

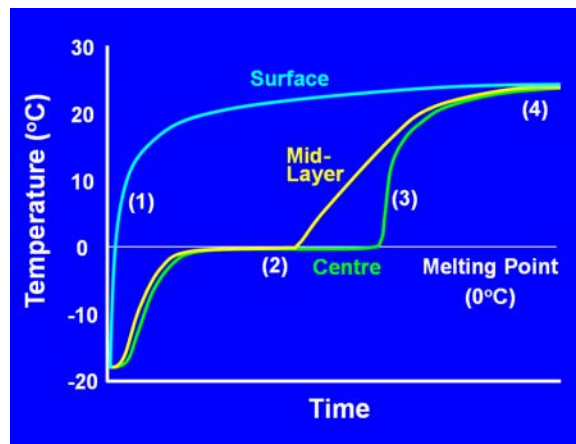
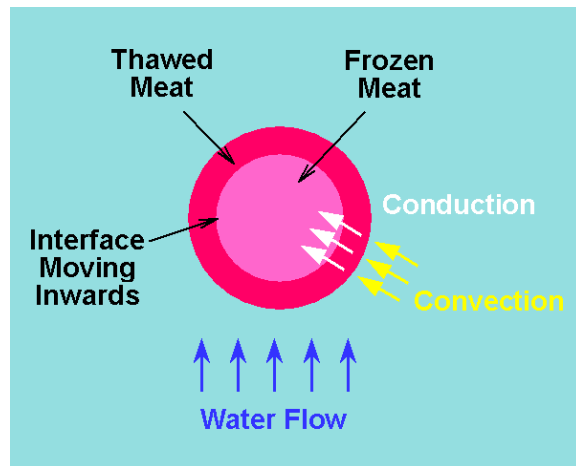
Cold water thawing of frozen meat is widely adopted in restaurants, hotels and other related industries. In a recent study, it was found that the common practices of cold water thawing method could be improved to achieve significant environmental and economic benefits. This booklet provides guidelines for effective and environmental use of this method to speed up the thawing process and, at the same time, to minimise the use of water and sewage treatment.

Theory

In a cold water thawing process, the two major modes of heat transfer are convection and conduction. The surface of meat gains heat from the surrounding water by convection and the heat is conducted into the body.

The meat temperature profiles during the thawing process are described as follows:

- (1) Meat surface temperature quickly increases and approaches the water temperature.
- (2) Meat centre temperature increases to about the melting point (0°C) and stays for a certain period of time.
- (3) Once the centre temperature exceeds the melting point, the meat is completely thawed. The centre temperature then increases abruptly.
- (4) Meat eventually reaches the equilibrium at the surrounding water temperature.



When the water flow rate is increased to a certain extent, further increase will not yield a noticeable reduction in the thawing time. It is because conduction, which is not directly affected by the water flow, becomes the mode that really restricts the overall heat transfer. Exceeding water flow rate does not speed up the thawing process. Conversely, the consequences are inefficient use of water and high water and sewage treatment charges.

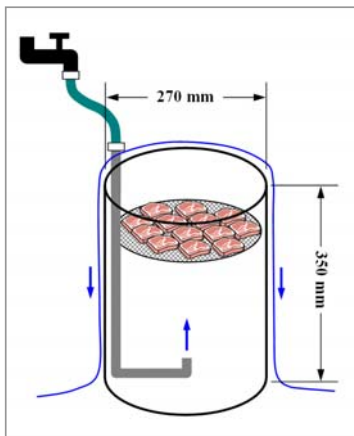
Recommended Cold Water Thawing Method

The following simple equipment and operating procedures are specially designed for effective cold water thawing used in a restaurant environment. The upward water flow with meat placed at a higher position can minimize the stratification problem and, thus, improve the convective heat transfer. The recommended method can save 90% water consumption, water and sewage treatment charges.



Equipment design

- Parts:
- 20-litre container (270 mm diameter and 350 mm height).
 - Fixed PVC pipe.
 - Flexible tube.
 - Stainless steel rack positioned in the upper part of the container.



Operation

1. Fill up the container with tap water.
2. Take about **2 kg** of frozen meat from freezer at -18°C ; refer to Tables 2 to 21 for approximate number of pieces of meat.
3. Spread the pieces evenly on the rack; make sure all pieces are fully immersed in the water.
4. Adjust running water at about **0.5 litre per minute*** (corresponding speed of water flow of 9 mm per minute inside the container).
5. Refer to Tables 2 to 21 for required thawing time.



*Note: It is easy to regulate the flow rate of running water. Before connecting the flexible tube, a measuring cup and a timer can be used to measure the water flow rate. The tap is adjusted to supply water at about 0.5 litre per minute. The tap position can be marked to facilitate future use.

Large-scale thawing

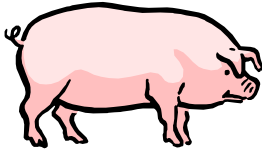
When simultaneous thawing of more frozen meat is required, a larger water container can be used. The increase in frozen meat capacity and the increase in thawing water flow rate are directly proportional to the increase in the square of the container diameter. For these variations, the speed of water flow inside the container can be maintained at a speed of 9 mm per minute. It is not necessary to increase the height of water container. Please refer to Table 1 for the numerical values. The thawing time recommendations shown in Tables 2 to 21 are still applicable.

Table 1. Frozen meat capacity and water flow rate varying with diameter of water container

Diameter (mm)	Maximum amount of frozen meat (kg)	Water flow rate (litre/min)
270	2	0.5
400	4	1.1
500	7	1.7
600	10	2.5
700	13	3.4
800	18	4.4
900	22	5.6
1000	27	6.9

Timetables for Recommended Cold Water Thawing Method

Pork



Spareribs



Approximate quantity:

- 200 pieces

- Total weight 2 kg

Table 2. Relationship between body temperature and process time in thawing of frozen spareribs based on water supply at 24°C

Centre Temperature (°C)	Mid-Layer Temperature (°C)	Time Taken (min)
-18	-18	0
-10	-6	1
-8	-5	1
-6	-3	2
-4	-2	2
-2	-1	3
-1	-1	3
0	17	12
2	17	12
4	17	12

Note: Average water supply temperature was 24°C between April 2003 and March 2004.

Table 3. Time for complete thawing of frozen spareribs at different water supply temperature

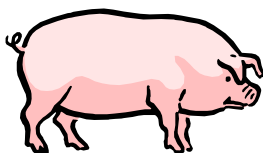
Water Supply Temperature (°C)	Corresponding Outdoor Air Temperature (°C)	Thawing Time (min)
10	6	23
15	13	18
20	19	14
25	25	11
30	31	10

Note: Complete thawing refers to the condition that the centre temperature immediately exceeds the melting point at 0°C

Timetables for Recommended Cold Water Thawing Method

(Cont.)

Pork



Pork chops



Approximate quantity:

- 30 pieces

- Total weight 2 kg

Table 4. Relationship between body temperature and process time in thawing of frozen pork chops based on water supply at 24°C

Centre Temperature (°C)	Mid-Layer Temperature (°C)	Time Taken (min)
-18	-18	0
-10	-6	5
-8	-4	6
-6	-3	7
-4	-2	8
-2	-1	10
-1	0	11
0	17	41
2	17	41
4	17	41

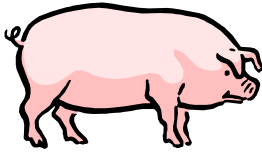
Table 5. Time for complete thawing of frozen pork chops at different water supply temperature

Water Supply Temperature (°C)	Corresponding Outdoor Air Temperature (°C)	Thawing Time (min)
10	6	84
15	13	64
20	19	49
25	25	40
30	31	36

Timetables for Recommended Cold Water Thawing Method

(Cont.)

Pork



Chunks



Approximate quantity:

- 2 pieces

- Total weight 2 kg

Table 6. Relationship between body temperature and process time in thawing of frozen chunks of pork based on water supply at 24°C

Centre Temperature (°C)	Mid-Layer Temperature (°C)	Time Taken (min)
-18	-18	0
-10	-5	28
-8	-4	32
-6	-3	38
-4	-2	44
-2	-1	55
-1	0	65
0	18	231
2	18	231
4	18	231

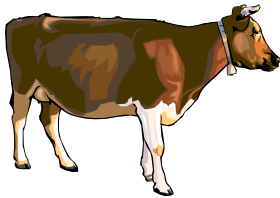
Table 7. Time for complete thawing of frozen chunks of pork at different water supply temperature

Water Supply Temperature (°C)	Corresponding Outdoor Air Temperature (°C)	Thawing Time (min)
10	6	454
15	13	352
20	19	275
25	25	222
30	31	193

Timetables for Recommended Cold Water Thawing Method

(Cont.)

Beef



Stews



Approximate quantity:

- 120 pieces

- Total weight 2 kg

Table 8. Relationship between body temperature and process time in thawing of frozen beef stews based on water supply at 24°C

Centre Temperature (°C)	Mid-Layer Temperature (°C)	Time Taken (min)
-18	-18	0
-10	-6	1
-8	-5	2
-6	-3	2
-4	-2	2
-2	-1	3
-1	0	3
0	17	10
2	17	10
4	17	10

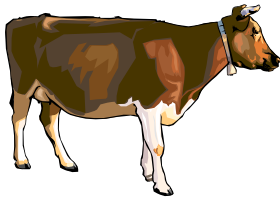
Table 9. Time for complete thawing of frozen beef stews at different water supply temperature

Water Supply Temperature (°C)	Corresponding Outdoor Air Temperature (°C)	Thawing Time (min)
10	6	19
15	13	15
20	19	12
25	25	9
30	31	8

Timetables for Recommended Cold Water Thawing Method

(Cont.)

Beef



Steaks



Approximate quantity:

- 12 pieces

- Total weight 2 kg

Table 10. Relationship between body temperature and process time in thawing of frozen steaks based on water supply at 24°C

Centre Temperature (°C)	Mid-Layer Temperature (°C)	Time Taken (min)
-18	-18	0
-10	-6	5
-8	-4	6
-6	-3	7
-4	-2	8
-2	-1	10
-1	0	12
0	17	34
2	17	34
4	17	34

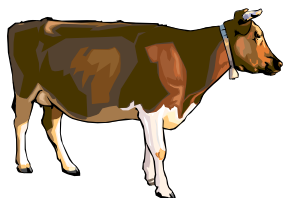
Table 11. Time for complete thawing of frozen steaks at different water supply temperature

Water Supply Temperature (°C)	Corresponding Outdoor Air Temperature (°C)	Thawing Time (min)
10	6	68
15	13	53
20	19	41
25	25	33
30	31	29

Timetables for Recommended Cold Water Thawing Method

(Cont.)

Beef



Chunks



Approximate quantity:

- 2 pieces

- Total weight 2 kg

Table 12. Relationship between body temperature and process time in thawing of frozen chunks of beef based on water supply at 24°C

Centre Temperature (°C)	Mid-Layer Temperature (°C)	Time Taken (min)
-18	-18	0
-10	-5	30
-8	-4	34
-6	-3	40
-4	-2	47
-2	-1	57
-1	0	67
0	18	196
2	18	196
4	18	196

Table 13. Time for complete thawing of frozen chunks of beef at different water supply temperature

Water Supply Temperature (°C)	Corresponding Outdoor Air Temperature (°C)	Thawing Time (min)
10	6	384
15	13	299
20	19	234
25	25	189
30	31	164

Timetables for Recommended Cold Water Thawing Method

(Cont.)

Chicken



Wings



Approximate quantity:

- 50 pieces

- Total weight 1.7 kg

Table 14. Relationship between body temperature and process time in thawing of frozen chicken wings based on water supply at 24°C

Centre Temperature (°C)	Mid-Layer Temperature (°C)	Time Taken (min)
-18	-18	0
-10	-6	1
-8	-5	2
-6	-3	2
-4	-2	2
-2	-1	3
-1	0	3
0	17	11
2	17	11
4	17	11

Table 15. Time for complete thawing of frozen chicken wings at different water supply temperature

Water Supply Temperature (°C)	Corresponding Outdoor Air Temperature (°C)	Thawing Time (min)
10	6	23
15	13	18
20	19	14
25	25	11
30	31	9

Timetables for Recommended Cold Water Thawing Method

(Cont.)

Chicken



Drumsticks



Approximate quantity:

- 30 pieces

- Total weight 2 kg

Table 16. Relationship between body temperature and process time in thawing of frozen drumsticks based on water supply at 24°C

Centre Temperature (°C)	Mid-Layer Temperature (°C)	Time Taken (min)
-18	-18	0
-10	-6	5
-8	-4	6
-6	-3	7
-4	-2	9
-2	-1	11
-1	0	13
0	17	40
2	17	40
4	17	40

Table 17. Time for complete thawing of frozen drumsticks at different water supply temperature

Water Supply Temperature (°C)	Corresponding Outdoor Air Temperature (°C)	Thawing Time (min)
10	6	84
15	13	63
20	19	48
25	25	39
30	31	34

Timetables for Recommended Cold Water Thawing Method

(Cont.)

Chicken



**Whole chicken /
with a package of
internal organs in
the core**



Approximate quantity:

- 2 pieces
- Total weight 2 kg

Table 18. Relationship between body temperature and process time in thawing of frozen whole chickens with internal organs based on water supply at 24°C

Inner Surface Temperature (°C)	Mid-Layer Temperature (°C)	Time Taken (min)
-18	-18	0
-10	-3	17
-8	-2	24
-6	-1	26
-4	0	33
-2	3	44
-1	6	54
0	14	99
2	15	106
4	16	115

Table 19. Time for complete thawing of frozen whole chickens with internal organs at different water supply temperature

Water Supply Temperature (°C)	Corresponding Outdoor Air Temperature (°C)	Thawing Time (min)
10	6	278
15	13	202
20	19	146
25	25	109
30	31	91

Note: The thawing time refers to the time at which the inner surface of the chicken immediately exceeds the melting point at 0°C. At this time, the package of internal organs is still frozen.

Timetables for Recommended Cold Water Thawing Method

(Cont.)

Chicken



**Whole chicken /
with empty core**



Approximate quantity:
- 2 pieces
- Total weight 1.7 kg

Table 20. Relationship between body temperature and process time in thawing of frozen whole chickens with an empty core based on water supply at 24°C

Thigh Temperature (°C)	Mid-Layer Temperature (°C)	Time Taken (min)
-18	-18	0
-10	-6	8
-8	-4	9
-6	-3	10
-4	-2	12
-2	-1	15
-1	0	18
0	18	54
2	18	54
4	18	54

Note: In this thawing process, the thighs, the thickest parts of the chicken body, will have the lowest temperature. Therefore, the temperature is used as the indicator for complete thawing.

Table 21. Time for complete thawing of frozen whole chickens with empty core at different water supply temperature

Water Supply Temperature (°C)	Corresponding Outdoor Air Temperature (°C)	Thawing Time (min)
10	6	111
15	13	85
20	19	66
25	25	52
30	31	45

Note: The thawing time refers to the time at which the thigh temperature immediately exceeds the melting point at 0°C.